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DIET AND MORPHOMETRICS OF *COLUBER* (=*HIEROPHIS*) *VIRIDIFLAVUS* ON THE ISLAND OF MONTECRISTO (TYRRHENIAN SEA, ITALY)

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The European whip snake, *Coluber* (=*Hierophis*) *viridiflavus* is a common colubrid snake of the Mediterranean region, ranging from western and N.E. France to Switzerland, and to Italy and most of the western Mediterranean islands. It inhabits a great variety of habitats and ranges up to 2000 m asl (Naulleau, 1997). This species is characterized by a large body size, up to 200 cm in length (Bruno & Maugeri, 1990), and has a widespread distribution and habitat use (Bruno & Maugeri, 1990; Scali & Zuffi, 1994). The European whip snake consumes a wide variety of prey (Bruno & Maugeri, 1990; Luiselli & Angelici, 1996; Capula, Filippi, Luiselli & Trujillo Jesus, 1997), and also displays an ontogenetic shift in diet composition (Bruno & Maugeri, 1990; Rugiero & Luiselli, 1995), as typically observed in several other snake species (Luiselli & Agrimi, 1991; Luiselli, Capula & Shine, 1996). Of particular interest is the ecology (i.e. feeding ecology, thermal preferences), and activity of this species in areas or habitats where potential competitors are limited in number or absent (e.g. small islands), compared with areas where potential competitor species are common and abundant (e.g. natural parks of coastal areas, large islands). The feeding ecology of *C. viridiflavus* on the Mediterranean islands is still incompletely known, and further research and additional data could be useful to confirm most patterns of the phenotypic plasticity observed (Bruno, 1968, 1975; Delaugerre & Cheylan, 1992). The island of Montecristo was chosen for study because of the presence of only one other, competitor snake species, *Vipera aspis hugyi* (Societas Herpetologica Italica, 1996) and because of the very small size of the island. It is generally assumed that in restricted or closed habitats the amount of food resources can fluctuate markedly in time, as also can the relative predator density (Andrén & Nilson, 1983). In this short note, I present and discuss (1) new data on diet, and (2) additional natural history data for *Coluber* (=*Hierophis*) *viridiflavus*.

During a five-year research project on integrated ecology and systematic aspects of the Mediterranean snake fauna, it was possible to visit the Natural Reserve of the island of Montecristo, an area highly protected for breeding and migratory birds (Meschini & Frugis, 1993), and for the presence of a large population of the wild goat (*Capra aegagrus hircus*), a naturalized species introduced by pre-historic man probably 6000 years B.C. (Masseti, 1993). This small island is about 10 km^2 in area, mainly granitic, with typical Mediterranean vegetation, comprising a small woodland of introduced *Pinus pinea*, and sparse autochthonous relict *Quercus ilex* trees. The average temperature in July is about 24 °C (Pavan, 1989). The research was carried out from 0630 hr to 2030 hr, during the week of 5-11 June 1999, along a 1450 m long and 300 m wide transect, selected as a representative selection of habitat patterns on the island. The transect ran from the sandy beach at sea level in the west, eastwards through a pine-wooded area, and along a temporary stream with permanent small ponds and ended at the medium-altitude, bush-covered central part of the island. The transect was walked three times a day, at 0700 hr, 1100 hr (in the opposite direction), and 1700 hr. The starting point of the first survey alternated between days, i.e. on one day it was at the coast, while on the the following day it was at the central part of the island. Each transect survey lasted about three hours. Meteorological data were taken from 0400 to 2400 hrs, on average at two hour intervals; shaded air temperature at 10 cm above ground and relative humidity were recorded; data were presented as average ± 1 SD and range (minimum-maximum values, sample size). Snakes were captured between about 100 m and more than 1200 m away from the coast, and from 10 m to 240 m asl. Snout-vent length (SVL, precision 1 mm), total length (TL, precision 1 mm), number of ventral scales (VS), body mass (BM, precision 0.5 g) and tail condition (0 = intact tail, 1 = damaged tail) and sex for each captured snake were recorded. Each morphometric variable was log-transformed prior to the analyses and tested for normality, then processed with parametric or non-parametric statistics, according to a normality test. Statistical analyses were carried out with SPSS 6.1.2.

Average air temperature (mean of daily means) during the study was 25.2±1.8 °C (21.8-30.4, n=46), and average relative humidity was 59±11.4 % (34-82, n=33). I observed 17 adult and two subadult snakes, and captured 11 of them – seven adult and one subadult males and three adult females. In 17 out of 19 encounters, the snakes were very close to the water (i.e. less than 2 m distance, n=7) or directly in the water (n=10), either basking or searching for food. Two snakes were close to areas of bushes and rocks, more than 100 m from the closest humid area. Air temperature at the time of capture was 25.61±1.32 °C (24-27.6; n=9), ground temperature was 28.25±2.75 °C (25.6-33; n=8); these values appear to be higher than those recorded during the limited available field records for basking activity of *Coluber* (=*Hierophis*) *viridiflavus* in northern Italy (Scali & Zuffi, 1994) and central Italy (Capula *et al.*, 1997). They are, however, similar to those in the only available report for the species on this island, with a range at capture of 16.6-33.4°C (Bruno, 1975: page 78). Fourteen whip snakes were encountered between 0800

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TABLE 1. Biometric and dietary data for *Coluber* (=*Hierophis*) *viridiflavus* from the island of Montecristo. Sex: M = male, F = female; tail: 0 = intact, 1 = damaged. For further explanations see text.

snake no.	sex	total length (mm)	SVL (mm)	No. ventrals	Tail	Food remains
1	M	107	77	204	0	no data
2	M	89	79	210	1	no data
3	M	107	78.5	205	0	*Discoglossus* (femur, ribs); formicidae; tenebrionidae
4	M	91	66.5	214	0	no data
5	M	88	64.5	209	0	*Discoglossus* (vertebrae, ribs); formicidae; tenebrionidae
6	M	116	85	206	1	no data
7	M	107	78	204	0	*Discoglossus* (vertebrae); formicidae; Coleoptera indet.
8	M	/	55.4	207	0	Empty
9	F	60	55.4	222	1	*Discoglossus* (skin)
10	F	95	71.9	207	0	Empty (gravid female, three developing eggs)
11	F	104	77	219	0	no data

and 1259 hrs (no. captured=8), and five were encountered between 1730 and 1810 (no. captured=3). These observations suggest a bimodal cycle of daily activity which is probably common during the hot months (Capula *et al.*, 1997: page 72), although most activity patterns in snake species can be fully explained only from prolonged field studies or by using radio tracking procedures (Ciofi & Chelazzi, 1991; Naulleau, 1992).

Considering the relative scarcity of biometric data on the whip snake from Mediterranean islands (Bruno, 1968, 1975; Schätti & Vanni, 1986; Delaugerre & Cheylan, 1992; Zuffi, 2000), all raw data on specimens captured during the present study are given in Table 1. Three out of eight males and one out of three females had damaged tails; this is consistent with a relatively high incidence of attempted predation on this island population, or perhaps an effect of parasites that may destroy the tail (personal observation). Alternatively, it could have resulted from natural tail breakage, which occasionally occurs in snakes (Mendelson III, 1992). Owing to the reduced TL sample size, it was impossible to perform any meaningful statistical analysis on this variable. In addition to 11 adult snakes captured during this study, I have added measurements of 16 adults (nine males and seven females) reported by Bruno (1968: page 53). Male whip snakes measured 741±98 mm SVL (534-873 mm, n=17), weighed 76.6± 0.7 g BM (n=8), and had 205.9±3.6 VS (200-214, n=19); females measured 681±79 mm SVL (554-790 mm, n=10) and had 217.4±6.0 VS (207-230, n=10); the two females weighed had a BM of 65 g and 77 g, respectively. Adult SVL did not differ significantly between the two sexes (t=1.6, df=25, P=0.122), whereas males had fewer ventral scales (t= 6.48, df=27, P=0.0001). Data presented by Schätti & Vanni (1986: Fig. 1, on page 223) for the Montecristo whip snakes overlap the data in this study. Furthermore, both data sets confirm that *C. viridiflavus* of Mediterranean islands are characterized by smaller body size and greater number of VS than those of mainland Italy. According to Schätti & Vanni (1986), island males average 780-895 mm SVL with 203-206 VS whereas mainland males average 830-1089 mm SVL with 194-201 VS; island females average 784-820 mm SVL with 217-223 VS whereas mainland females average 700-909 mm SVL with 205-213 VS. The results confirm the previously observed sexual dimorphism of this taxon (Springolo & Scali, 1998), and that small-island whip snakes have, on average, a greater number of ventral scales and smaller body size than mainland populations (Schätti & Vanni, 1986; Delaugerre & Cheylan, 1992; Zuffi, 2000; Zuffi, Corti & Luiselli, 2000).

Smaller body size and a greater number of ventral scales in small island populations is a pattern often found in this taxon (Schätti & Vanni, 1986; Delaugerre & Cheylan, 1992; Zuffi *et al.*, 2000), and quite often in other colubrid species (Corti, Zuffi & Luiselli, 2000; Zuffi *et al.*, 2000). A smaller body size could be favourable in terms of a reduced energy requirement, but it may also be involved in a different reproductive strategy (Zuffi, 2000; Zuffi *et al.*, 2000). Alternatively, a smaller body size may be interpreted as a result of low energy availability, not necessarily indicating any adaptive pattern.

I examined the intestinal contents of three of the 11 adult snakes that were kept for two days in enclosures, and of another three that were retained as voucher material according to the EU INTERREG II project Corsica-Tuscany. *Discoglossus sardus*, the only amphibian species present on Montecristo (Corti *et al.*, 1991), was the only vertebrate prey found (Table 1); the insects found in the food remains had almost certainly been eaten by the *Discoglossus* themselves. This observation was very different to those of Bruno (1968, 1975), who found that in May and July 1967 whip snakes on Montecristo had eaten small mammals (*Apodemus*), birds (*Motacilla*, *Phylloscopus*, *Phoenicurus*, *Muscicapa*, *Hippolais*), lizards (*Podarcis*) and their eggs, and locusts (*Locusta*). There was only one occurrence of *Discoglossus* in the diet of *C. viridiflavus* (Bruno 1968, 1975). Dietary data for *Coluber* (=*Hierophis*) from Montecristo are still scarce. The high incidence of tadpoles and adults of *Discoglossus* in the diet during my study may have reflected opportunistic

exploitation by the snakes of a seasonally abundant resource, or it may have resulted from the snakes seeking out water during a period of high temperature. Whether the snakes selected wet areas because of the hot weather, then fed on the most available prey, or selected wet areas because of the seasonal abundance of amphibian prey raises a more general question about the forces underlying prey selection by this species – a topic worthy of further research.

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REFERENCES

Andrén, C. & Nilson, G. (1983). Reproductive tactics in an island population of adders, *Vipera berus*, (L.), with a fluctuating food resource. *Amphibia-Reptilia* **4**, 63-79.

Bruno, S. (1968). Gli Anfibi e i Rettili dell' Isola di Montecristo (Studi sulla fauna erpetologica italiana, IX). *Atti Soc. Tosc. Sc. Nat. Mem.* B: **75**, 31-71.

Bruno, S. (1975). Note riassuntive sull'erpetofauna dell'Isola di Montecristo (Arcipelago Toscano, Mare Tirreno) (Studi sulla fauna erpetologica italiana. XX) (Studi sulla Riserva Naturale dell'Isola di Montecristo. XVIII). *Lavori Soc. Ital. Biogeog.* **5** (1974), 743-838.

Bruno, S. & Maugeri, S. (1990). *Serpenti d'Italia e d'Europa.* Milano: Mondadori.

Capula, M., Filippi, E., Luiselli, L. & Trujillo Jesus, V. (1997). The ecology of the Western Whip snake, *Coluber viridiflavus* (Lacépède, 1789), in Mediterranean Central Italy (Squamata: Serpentes: Colubridae). *Herpetozoa* **10**, 65-79.

Ciofi, C., & Chelazzi, G. (1991). Radiotracking of *Coluber viridiflavus* using external transmitters. *J. Herpetol.* **25**, 37-40.

Corti, C., Zuffi, M. A. L., & Luiselli, L. (2000). Sulla variazione geografica e biometria comparata della natrice dal collare, *Natrix natrix*, dell'area Mediterranea. *3° Congr. S.H.I.*, Pavia, 14-16 settembre 2000, *Riassunti*, 1 pag.

Corti, C., Nistri, A., Poggesi, M. & Vanni, S. (1991). Biogeographical analysis of the Tuscan herpetofauna (Central Italy). *Rev. Esp. Herp.* **5**, 51-75.

Delaugerre, M. & Cheylan M. (1992). *Atlas de repartition des Amphibiens et Reptiles de Corse.* Pamplona: Oikema.

Luiselli, L. & Agrimi, U. (1991). Composition and variation of diet of *Vipera aspis francisciredi* in relation to age and reproductive stage. *Amphibia-Reptilia* **12**,137-144.

Luiselli, L. & Angelici, F. M. (1996). The prey spectrum of terrestrial snakes in the Tolfa Mountains (Latium, Central Italy). A synthesis from earlier analysis. *Herpetozoa* **9**, 111-119.

Luiselli, L., Capula, M. & Shine, R. (1996). Reproductive output, costs of reproduction, and ecology of the smooth snake, *Coronella austriaca*, in the eastern Italian Alps. *Oecologia* **106**, 100-110.

Meschini, E. & Frugis, S. (1993). Atlante degli uccelli nidificanti in Italia. *Suppl. Ric. Biol. Selvaggina* **20**, 1-344.

Masseti, M. (1993). Post-Pleistocene variations of the non-flying terrestrial mammals on some Italian islands. *Suppl. Ric. Biol. Selvaggina* **21**, 209-217.

Mendelson, J. R. (1992). Frequency of tail breakage in *Coniophanes fissidens* (Serpentes: Colubridae). *Herpetologica* **48**, 448-455.

Naulleau, G. (1992). Activité et température corporelle automnales et hivernales chez le Coulevre d'Esculape *Elaphe longissima* (Squamata, Colubridae) dans le Centre Ouest de la France. *Bull. Soc. Herp. Fr.* **64**, 21-35.

Naulleau, G. (1997). *Coluber viridiflavus* (Lacépède, 1789). In: Gasc J. P. *et al.* (Eds.). Atlas of Amphibians and Reptiles in Europe. Societas Europaea Herpetologica & Muséum National d' Histoire Naturelle (IEGP/SPN), Paris: 342-343.

Pavan, M. (1989). *Isola di Montecristo. Riserva Naturale.* Collana verde 77/1989. Rome: Ministero Agricoltura e Foreste, Corpo Forestale dello Stato.

Rugiero, L. & Luiselli, L. (1995). Food habits of the snake *Coluber viridiflavus* in relation to prey availability. *Amphibia-Reptilia* **16**, 407-411.

Scali, S. & Zuffi, M. (1994). Report on a reptile community ecology in a suburban habitat of northern Italy (Reptilia, Sauria, Serpentes). *Boll. Zool.* **61**, 73-76.

Schätti, B. & Vanni, S. (1986). Intraspecific variation in *Coluber viridflavus* Lacépède, 1789, and validity of its subspecies (Reptilia, Serpentes, Colubridae). *Revue suisse Zool.* **93**, 219-232.

Societas Herpetologica Italica (1996). Atlante provvisorio degli Anfibi e dei Rettili italiani. *Annali Mus. Civ. St. Nat. "G.Doria"* **91**, 95-178.

Springolo, M. & Scali, S. (1998). Sexual dimorphism and ontogenetic changes in *Coluber viridiflavus*: a head morphometric analysis. In: Miaud, C. & Guyetant R. (Eds.). Societas Europaea Herpetologica, Le Bourget du Lac, France. 1998: 413-417.

Zuffi, M. A. L. (2000). Morphological and functional variability of the whip snake (*Hierophis viridiflavus*) from Corsica: a comparative approach to other Mediterranean islands and mainland. *Ambiente e Identità nel Mediterraneo, Bastia, Ajaccio, Corte 13-16 Giugno 2000*, Proceedings, 5 pp.

Zuffi, M. A. L., Corti, C. & Luiselli, L. M. (2000). Significato adattativo della variabilità morfologica nel biacco (*Hierophis viridiflavus*) del Mediterraneo. *61° Congr. UZI*, S. Benedetto del Tronto (AP), 24-28 settembre 2000, *Riassunti*, 1 p.

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